

Amateur Radio on the International Space Station (ARISS)

Program Status

ARISS 20 Years!!



2017 AMSAT-NA Symposium
Reno, Nevada
May 20, 2017

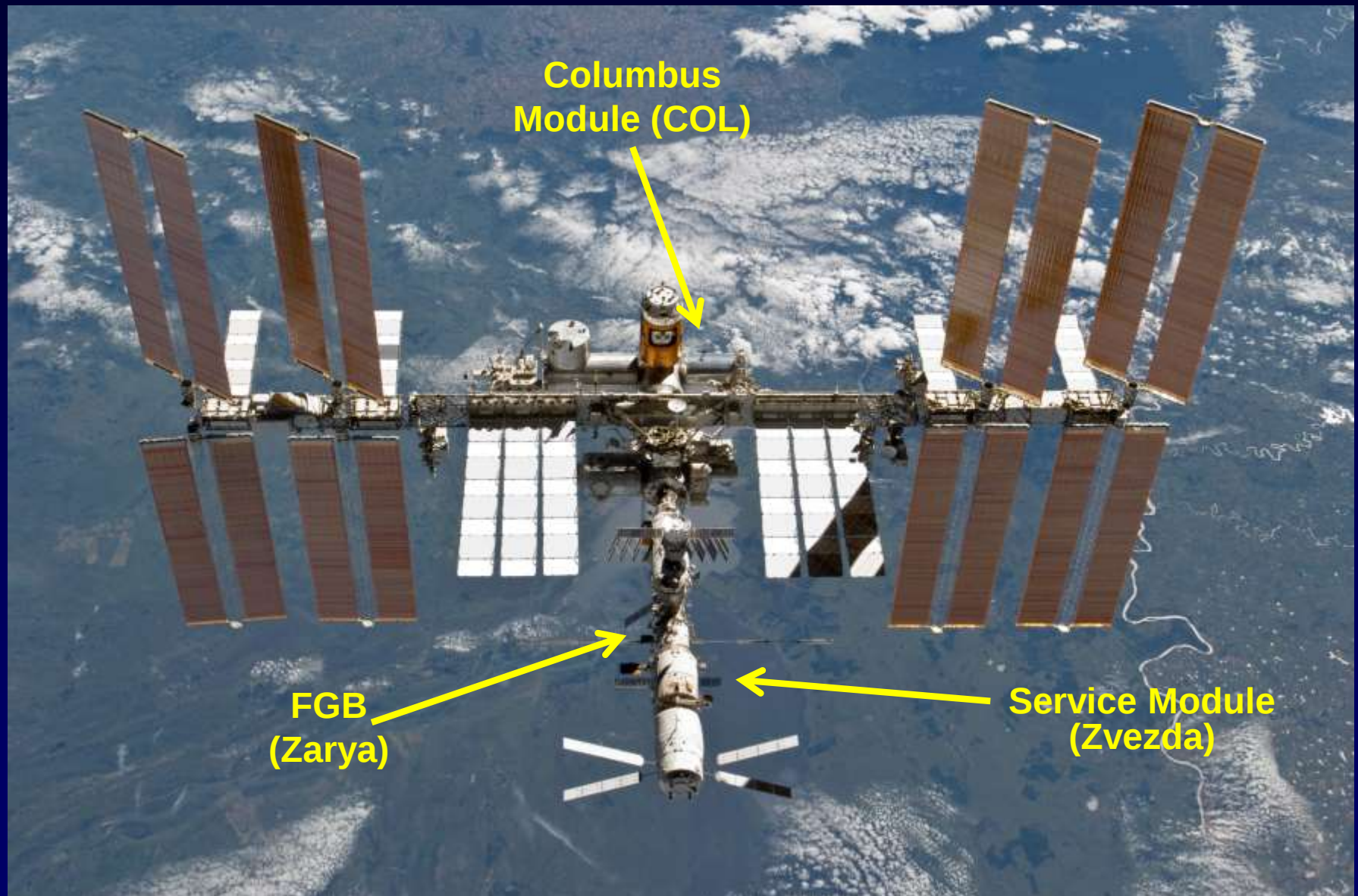
Frank H. Bauer, KA3HDO
David Taylor, W8AAS
Lou McFadin, W5DID

ARISS: 20th Anniversary!!

1st Meeting JSC Houston, November 4-5 1996



ARISS in the International Space Station



On-Orbit Capabilities



**VHF and UHF Voice in
Service Module (Zvezda)**

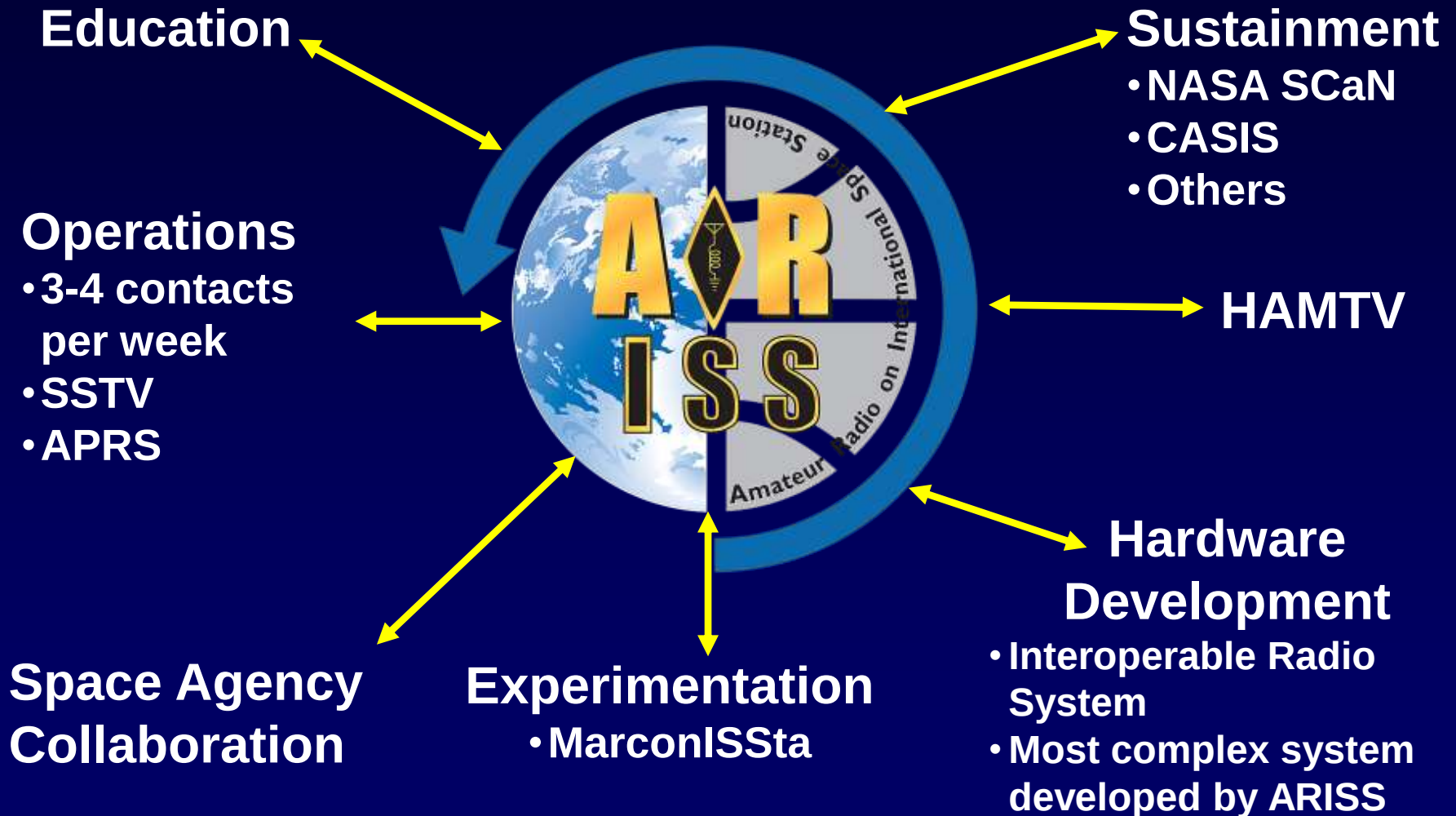
**VHF 2-way Voice and
APRS Packet (Digital) in
Columbus Module**

**Slow Scan TV (SSTV)
(Picture uplink and
downlink)**



**HAMTV in
Columbus**

Most In-Depth and Comprehensive Team Effort in 20 Years!!



We Could Use More Volunteer Help!!

ARISS Sustainment

ARISS Corporate Sponsorship Levels (Real Dollar and/or In-Kind) Proposed

- \$75,000 Astronaut
- \$50,000 Mission Control Director
- \$25,000 Space Scientist
- \$10,000 Engineer
- \$5,000 Mathematician
- \$1,000 Navigator
- \$500 Technician

ARISS Support

Astronaut Sponsors



**NASA Space Communication
and Navigation (SCaN)**



**Center for the Advancement
of Science In Space**



**AMSAT
Radio Amateur
Satellite Corporation**

Space Scientist Sponsors



**American Radio Relay
League (ARRL)**



**In-Kind support of D710 GA Radios
and Engineering Modifications**

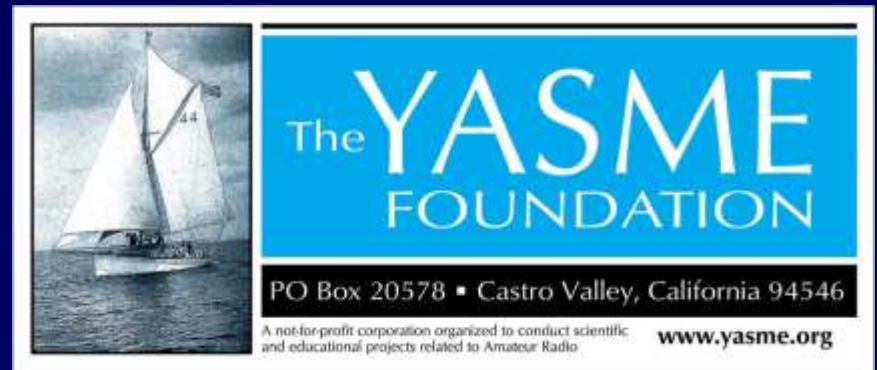
Special Thanks to:

Navigator Sponsor



Joe Lynch
N6CL

Technician Sponsors



2016 ARISS Annual Report

Amateur Radio on the
International Space Station
— **ARISS**



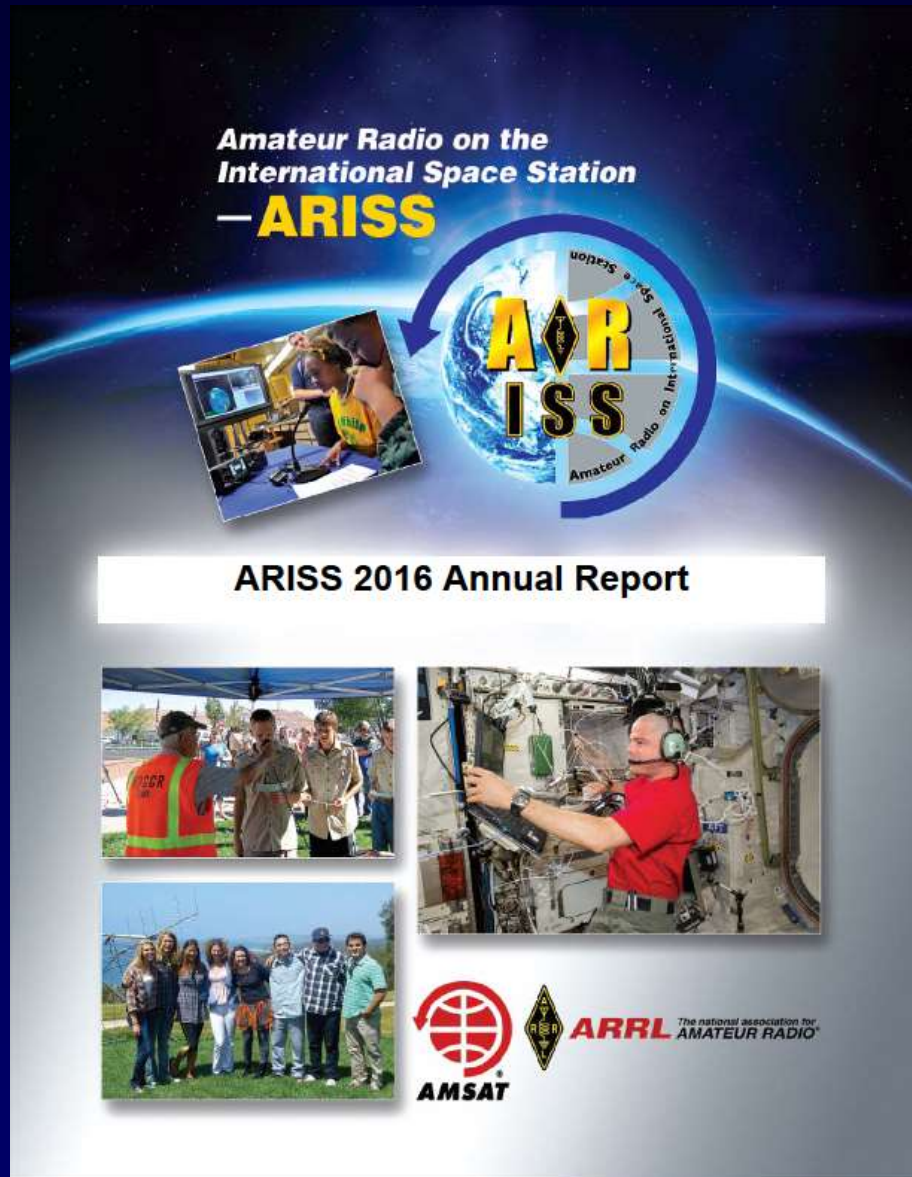
ARISS 2016 Annual Report



- Report completed March 1 2017 and delivered to our prime external sponsors: NASA SCaN & CASIS
- Annual Report can be downloaded from:
<https://www.dropbox.com/s/dt0e9ca7tnrjn34/ARISS%20Annual%20Report%202016%20Final.pdf?dl=0>
- 2016 Highlights:
 - Inauguration of HamTV w/ schools
 - Signed NASA Space Act Agreement between AMSAT-NA and NASA on behalf of the ARISS program
 - Celebrated our 1000th contact
 - Obtained 2016 financial sponsorship and a strategic educational partner with Center for the Advancement of Science in Space (CASIS)
 - Continued on next page

Critical Document to Communicate ARISS Outcomes & Garner Corporate Funding

2016 ARISS Annual Report (Continued)



- 2016 Highlights (Continued):
 - Unprecedented educational outreach during Tim Peake's Principia STEM education mission, 10 contacts, 9 with HamTV
 - ARISS students accompanied Tim Peake to visit UK Prime Minister Theresa May, including Jessica Leigh, M6LPJ, who obtained her license for Tim's mission and was first student to talk to Tim Peake on-orbit.
 - Celebrated 20th anniversary as a team with special celebration at Johnson Space Center international meeting
 - Great progress on design/development of Interoperable Radio System
 - 88 ARISS voice contacts over the course of the year
 - Conducted several contacts and supported ARISS Outreach at several major events for our benefactors—NASA SCaN and CASIS

2017 Fundraising Highlights

- Garnered 2018 (October 2017-October 2018) funding from:
 - CASIS to partially support ARISS Operations at JSC
 - NASA Space Communication & Navigation (SCaN) to partially support ARISS Operations at JSC
- Other major sponsors:
 - AMSAT-NA (Real \$ and substantial in-kind support--volunteer personnel)
 - ARRL (real \$, after departure of Debra Johnson; expect continued funding but minimal ARRL HQ personnel support in the future)
 - Dayton Amateur Radio Association (real \$), Joe Lynch, N6CL
- Interoperable Radio System (IORS) Expected Savings
 - IORS hardware team developing safety data package exclusively by volunteers
 - Expected Savings through this method ~\$100,000
- Challenge Coin funding:
 - Good response from amateur radio community
 - Current stock of challenge coins running out
 - Considering ordering new coin (larger, color back, 20th anniversary?)

2017 CASIS & SCaN Venues

Supported by ARISS

- **CASIS:** SEEC, Space Exploration Educator Conference, Houston, February **ARISS Contact**
- **CASIS:** Council for Space Science Supervisors Conference & NSTA, National Science Teachers Association, Los Angeles, Mar-Apr **ARISS Contact**
- **SCaN:** Girl Scouts North East Ohio, Cleveland, June **ARISS Contact**
- **CASIS:** ISS Research & Development Conference – Washington DC – July **ARISS Contact**
- **SCaN:** TDRS-M Launch, KSC Visitor's Center

**CASIS: Space Exploration Educators Conference
(SEEC) Feb 2017 ARISS contact at Space Center Houston (TX)
with students from Seabrook Middle School & ARISS Booth
Display with CASIS**



CASIS: NSTA Convention & Council of State Science Supervisors (CSSS), Mar-Apr 2017 Los Angeles, CA

ARISS shared booth with other CASIS Space Station Explorers programs at National Science Teachers Association national conference
CSSS hosted an ARISS contact with Shane Kimbrough, partnering with 3 elementary schools in Watts & South Central LA, with mostly Latino & African American students, 95-100% living in poverty



**Students Receive their QSL (Contact Confirmation)
Post Card After the ARISS Connection**

SCaN: NASA Glenn Research Center & Girl Scouts of NE Ohio Brook Park OH, June 23 2017



The young interviewers, GRC senior leadership, staff, & ARISS volunteers



Just a few of the 300+ intrepid girls

With the help of staff from NASA SCA_N, NASA Glenn Research Center, and Girl Scouts of Northeast Ohio, 300+ girl scouts engaged in educational activities involving a microgravity drop tower, lunar robotics, NASA space communications and navigation, amateur radio, vacuum chamber, electronics, ISS glove box, straw rockets, energy bead bracelets and more. Social media generated a great deal of interest, i.e., SCA_N uploaded the GSNEO poster and it garnered 5,185 impressions.

CASIS: ARISS Team Supports Space Station Explorers Booth at ISS R&D Conference Washington DC, July 2017



The ARISS Team set up a booth with hand-outs, hands-on activities with ARISS hardware, and a pull-up poster at the ISS Research & Development Conference. The booth was under the CASIS Space Station Explorers (SSE) umbrella; ARISS is one of the SSE programs.



The team staffed the booth throughout the conference, networking with educators, parents, students, ISS scientists, engineers, NASA staff, and industry people.

ARISS forged closer ties to the other SSE programs, as well.

SCaN: ARISS Supports SCaN's TDRS-M Launch Public Outreach Effort

KSC Visitor Center, Titusville FL, Aug 2017



- ARISS display included handout materials and an ARISS banner which was staffed by ARISS volunteer Dave Jordan, AA4KN for several days. Dave engaged educators, parents and members of the general public, promoting ARISS and school radio contact opportunities.

2018 CASIS Venues to be Supported by ARISS (Current Plan)

- SEEC, Space Exploration Educator Conference, Houston, February 1-8
- NSTA, National Science Teachers Association, Atlanta, March 15-18
- US Science and Engineering Festival, Washington DC, April 6-8 **ARISS Contact**
- S.P.A.C.E Space Port Area Conference for Educators, KSC, FL, July 11-13 **ARISS Contact**
- ISS Research & Development Conference – San Francisco – July 23-16 **ARISS Contact**
- NIH Children's Inn – Bethesda – TBD Date **ARISS Contact**

Education & Organizational Changes

ARRL Resignation, May 2017:

Debra Johnson, K1DMJ ARISS-US Education Lead

- Affected areas: ARISS Education, School Proposals, Web Page, ARISS Metrics, QSL Card Distribution, US Executive Team, ARRL Liaison
- Working with ARRL HQ on Transition
 - ARRL not backfilling ARISS education support person or administrative support
 - Expect continuance of support for press and legal/amateur radio matters
 - Plan to provide yearly check to ARISS at a lower support level--2017 check received
 - Requested ARISS liaison into ARRL
- Duties being temporarily reassigned to others. Rosalie, K1STO working School Proposals
- Sudden loss with little/no time for coordination has severely overburdened US executive team with added responsibilities
- Long term plan: ARISS Education Committee

Web Page Long Term Plan

- Install social media connections: Facebook, Twitter, YouTube, etc
- Develop ARISS.org Store
 - Web server provides e-commerce capability
 - Centralized buying with regional team members to distribute items
- Transfer responsibilities for web pages on upcoming contacts, Press notices, Ham TV, operations, archives—includes ARISS minutes, region pages, etc to individuals for development
- Redo of each page: International effort to “fix” pages to be up to date
- Each region have separate Proposal Page?
- Multiple languages?

13 Schools/Groups Selected for 1st Half 2018

- Competitive proposals selected by ARISS Education Review Team for ARISS radio time slots in first half of 2018

SCHOOL / ORGANIZATION	CITY & STATE
Bellefonte Area Middle School	Bellefonte PA
Central Islip Union Free School District	Central Islip NY
Central Magnet Math & Science Elementary School	Batesville AR
Freeport Public Schools	Freeport NY
Indian Trails Middle School	Winter Springs FL
Mill Springs Academy	Alpharetta GA
Moore Square AIG/GT Magnet School	Raleigh NC
Mooreland Heights Elementary	Knoxville TN
Museum of Science & Technology w/Danforth Middle School	Syracuse NY
Parkside Middle School	San Bruno CA
Pinson Valley High School	Pinson AL
Salado Intermediate School	Salado TX
Students for the Exploration & Development of Space	College Station TX

- ARISS Mentors assigned & schools/organizations submitting radio equipment plans

Request for Educational Proposals: 2nd Half 2018

OPEN NOW!

- Current window of opportunity for US educators to submit ARISS proposals for a radio contact with the ISS crew: September 15-November 15, 2017
- ARISS team developed new processes and modified team roles to support without ARRL Education leadership
 - Rosalie White, K1STO, temporarily leading effort as AMSAT volunteer
 - Moved all window of opportunity information to ARISS site
 - Updated proposal form and proposal guide
 - Developed new enrollment process using EventBrite to track interested educators
 - Recruited educator volunteers for ARISS Proposal Team to review proposals & make school/group selections

Operations Accomplishments

Worldwide School Participation - since 1st contact Dec 2000

- 1123 school/group contacts (1170 separate events)
- 46 US states & 2 US territories, 54 other countries
- FY17 Metrics:

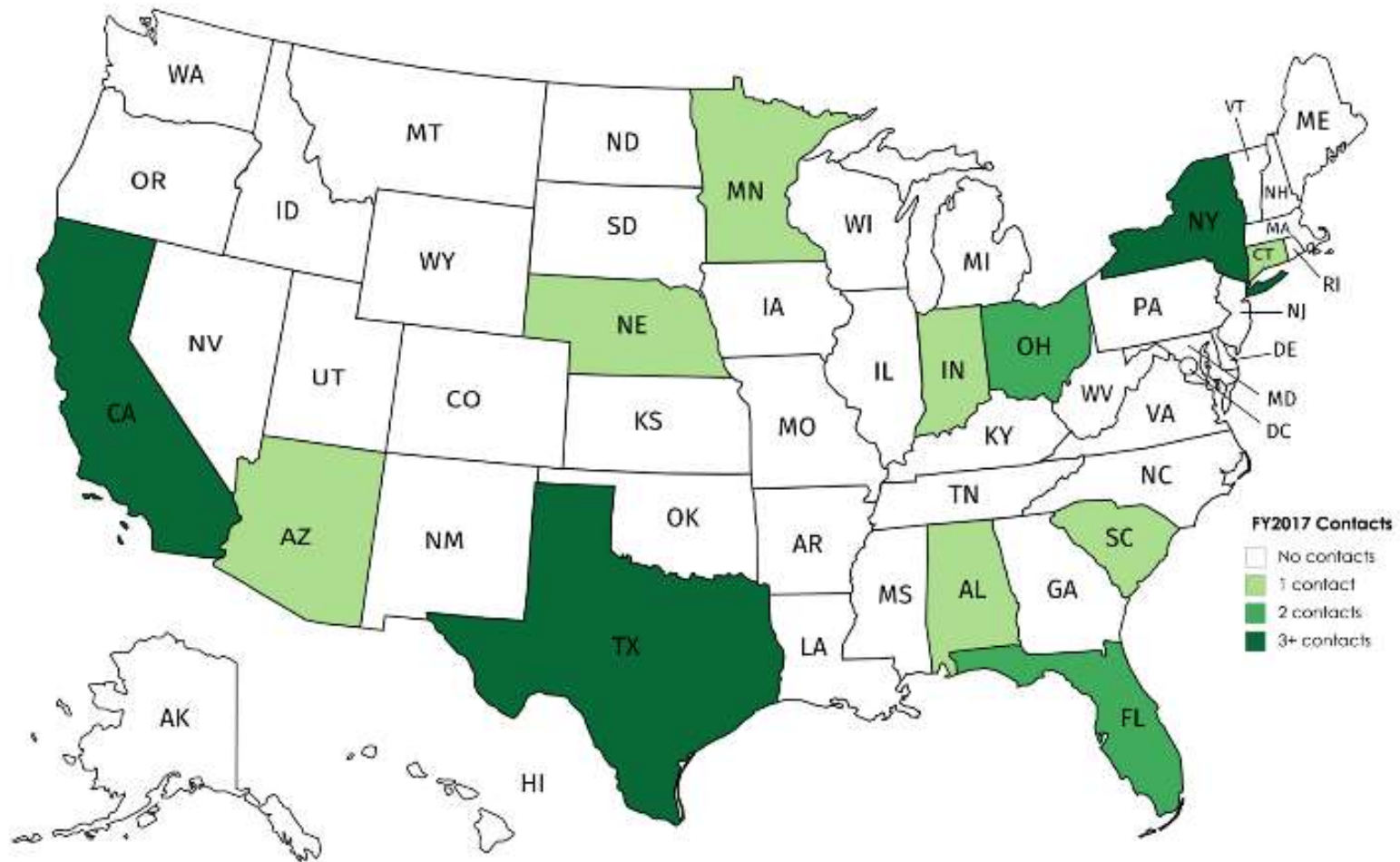
OCT 1-AUG 28 2017	1QFY17	2QFY17	3QFY17	4QFY17 (partial)
ARISS Total Reach	30,072	17,782	6,984	6,697
Students direct	6,478	6,917	2,047	2,081
Students indirect	15,617	6,626	2,197	2,584
Educators direct	270	387	288	177
Educators indirect	665	431	81	305
General public direct	2,816	786	576	755
General public indirect	4,226	2,635	1,795	795



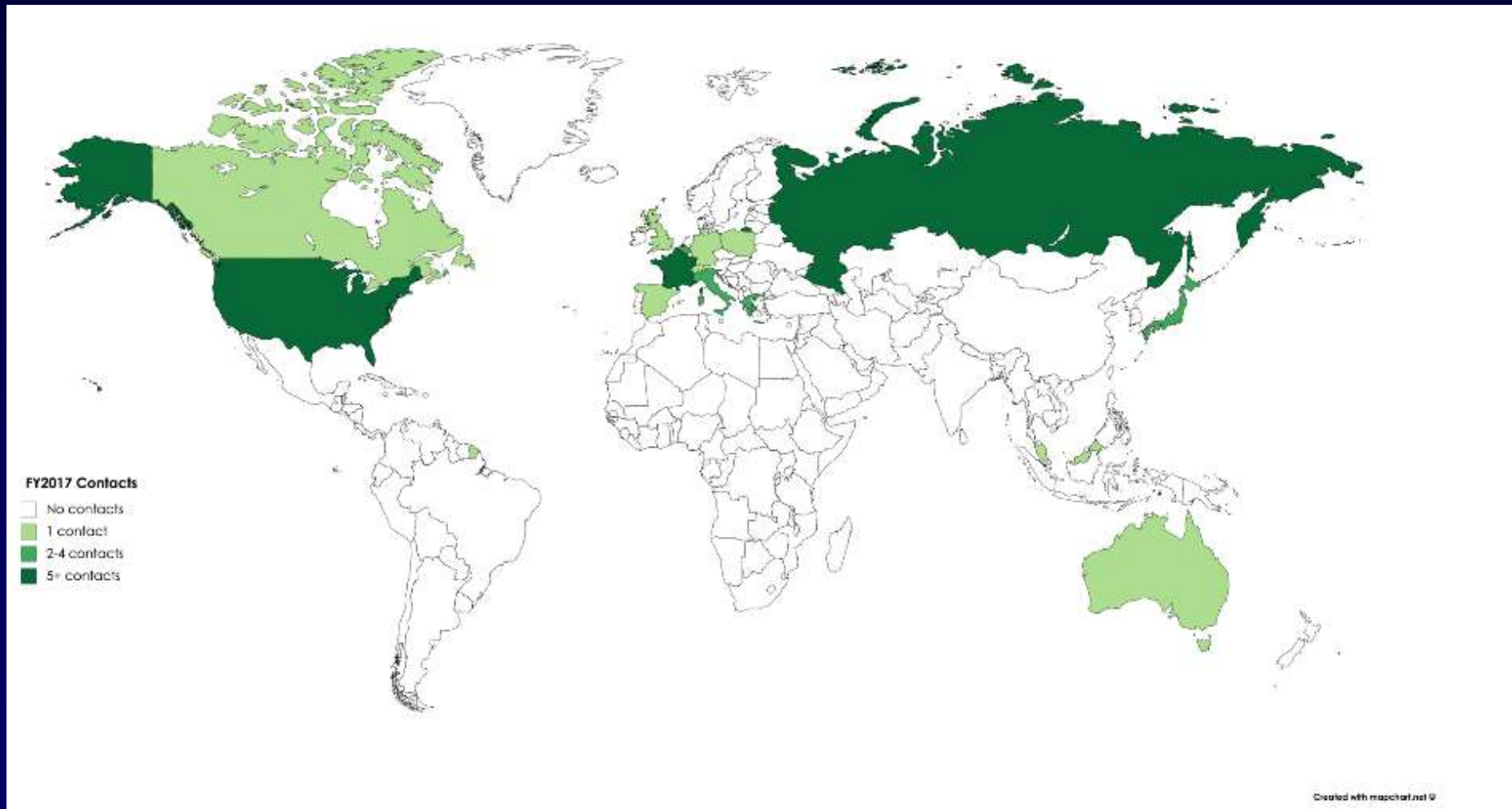
Thanks ARISS Mentors!!

USA Contacts

October 1, 2016-August 25, 2017



World Contacts (October 1, 2016-August 24, 2017)



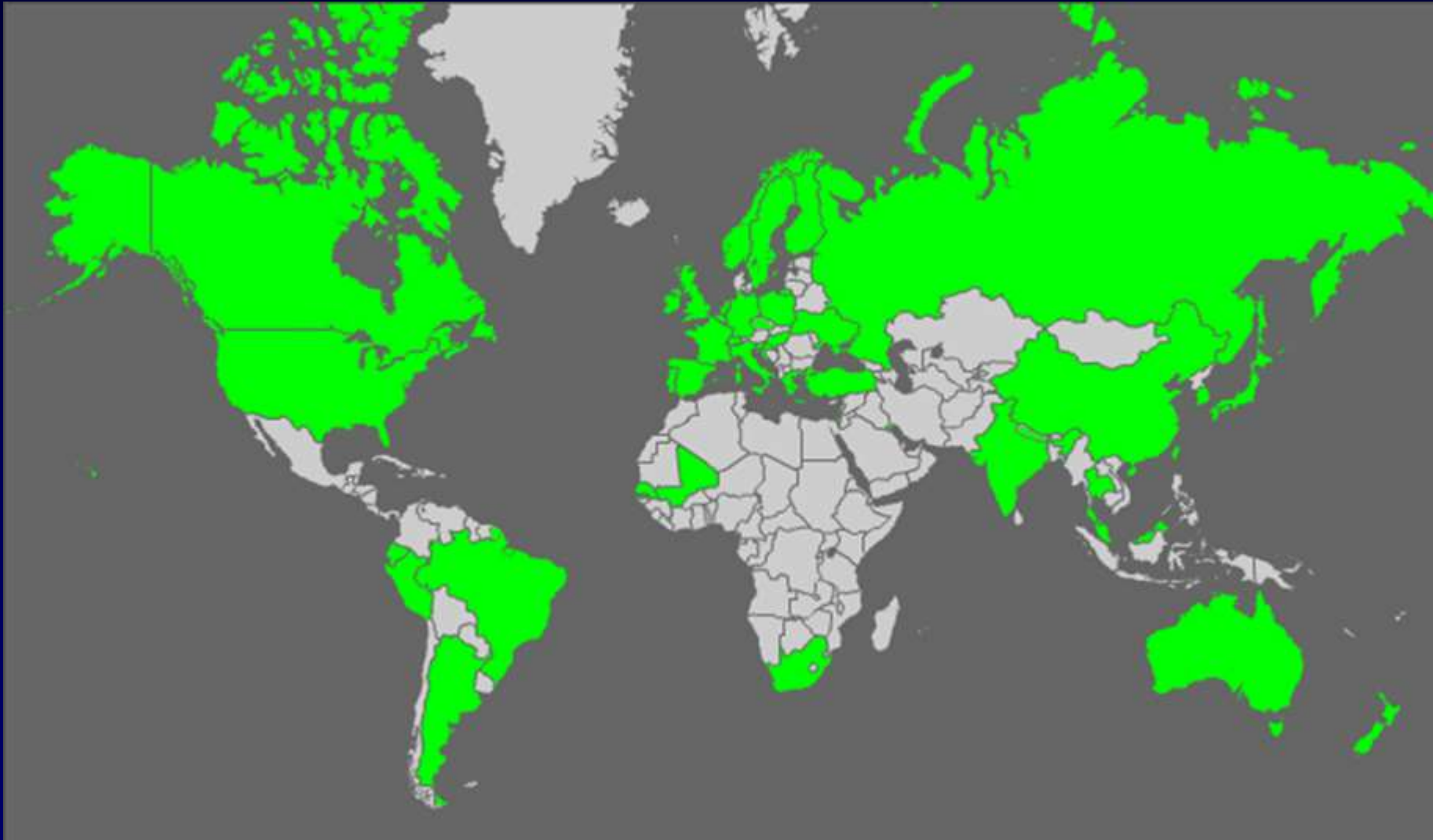
Breakdown by Country 2000–2017

1000+ successful school events in 54 countries

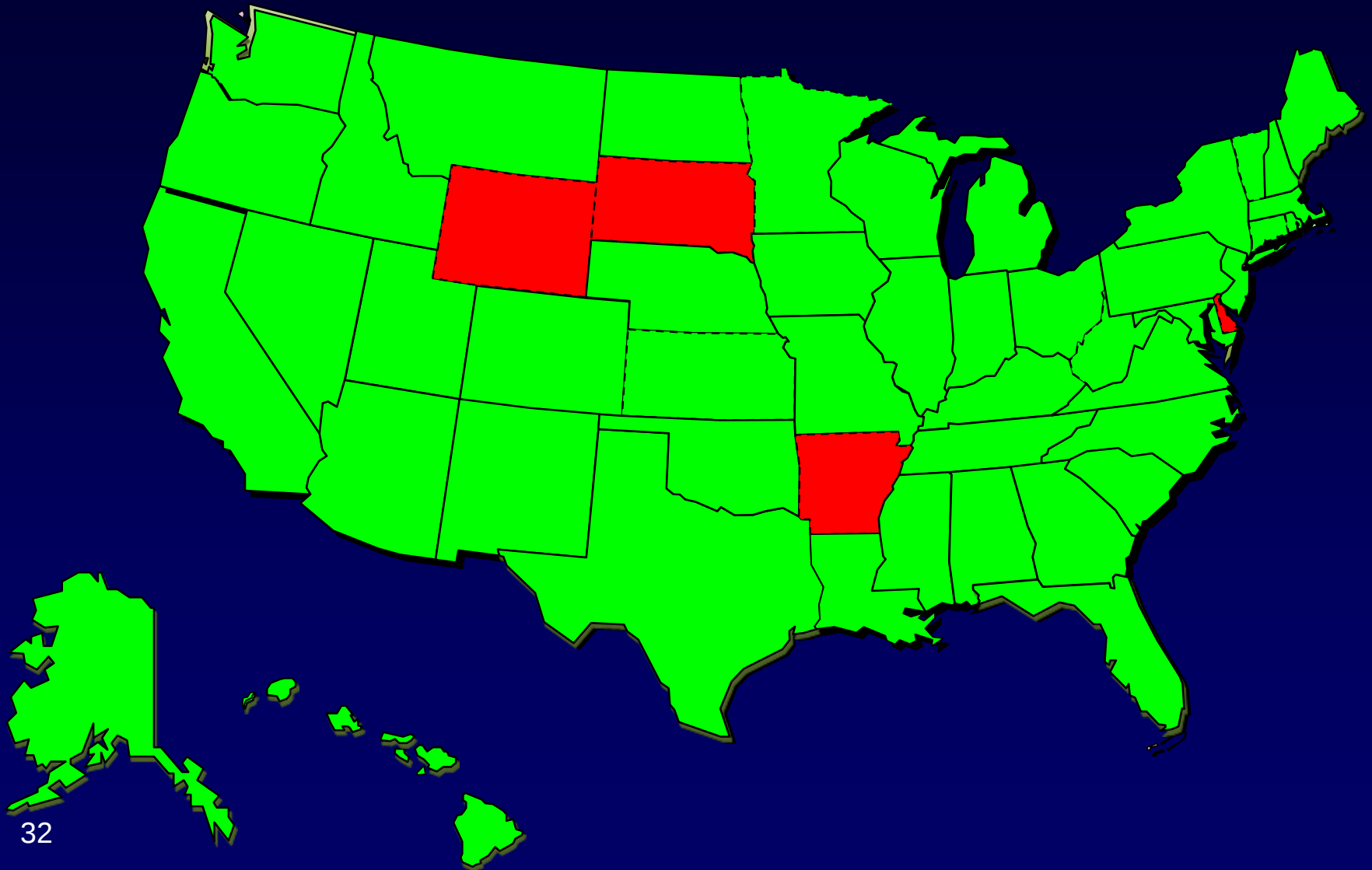
- ◆ Argentina
- ◆ Australia
- ◆ Austria
- ◆ Belgium
- ◆ Brazil
- ◆ Bulgaria
- ◆ Canada
- ◆ Chile
- ◆ Croatia
- ◆ Czech Republic
- ◆ Ecuador
- ◆ Finland
- ◆ France
- ◆ French Guiana
- ◆ Germany
- ◆ Greece
- ◆ Hungary
- ◆ India
- ◆ Ireland
- ◆ Israel
- ◆ Italy
- ◆ Japan
- ◆ Kuwait
- ◆ Luxembourg
- ◆ Malaysia
- ◆ Mali
- ◆ Monaco
- ◆ Nepal
- ◆ The Netherlands
- ◆ New Zealand
- ◆ Norway
- ◆ P. R. China
- ◆ Peru
- ◆ Poland
- ◆ Portugal
- ◆ Republic of Belarus
- ◆ Republic of Korea
- ◆ Romania
- ◆ Russia
- ◆ Senegal
- ◆ Slovenia
- ◆ South Africa
- ◆ Spain
- ◆ Sweden
- ◆ Switzerland
- ◆ Taiwan
- ◆ Thailand
- ◆ Trinidad & Tobago
- ◆ Turkey
- ◆ Ukraine
- ◆ United Kingdom
- ◆ United States
- ◆ Uruguay
- ◆ Vatican City

Countries with ARISS Contacts

2000 – Aug 28 2017



USA States & Territories, 2000 – Aug 28 2017



ARISS Slow Scan TV (SSTV) Transmissions Celebrate 20 Years of ARISS Operations July 21-24 2017



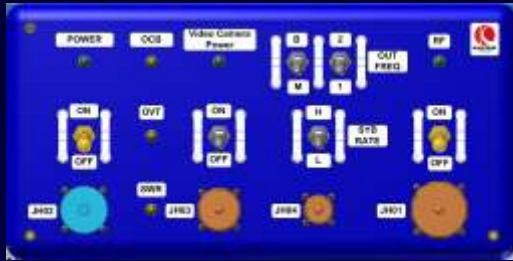
Two of Twelve ARISS SSTV Images Transmitted

- In celebration of ARISS and its years of operations onboard the International Space Station (ISS), the ARISS radios were activated for special transmissions of ARISS Slow Scan TV (SSTV) images. The 12 images, which were received by hams, students and shortwave listeners worldwide, depicted ARISS historical events.
- People uploaded their received images to the online ARISS SSTV Gallery. More than 1,800 were posted for public viewing. The ARISS Facebook page showed the reach of SSTV-related posts as 6,920.

HamTV

Ham TV Operational

Live Video from ISS!!



Ham TV Control
Module on
Columbus

HamTV ARISS contact between:

Norwich Schools, Norwich/East
Anglia, UK

Astronaut Tim Peake

February 26th, 2016



Ground Operations
Screen



ARISS L/S-band antennas
on Columbus



Ground System
Antennas



Matera Ground
Station Support

Operational with Schools February 11, 2016!

Help Wanted: Ham TV USA Ground Stations

- ARISS-US needs “Chained” ground stations to support US-based Ham TV (3-5 stations in various parts of the US aligned to ISS ground track)
- Since Dayton 2016, major initiative completed to document hardware and software systems needed to set up ground station. See: <http://www.amsat-on.be/hamtv-summary/>
- Please contact Lou McFadin, W5DID or Frank Bauer, KA3HDO if you have interest in supporting ARISS in this endeavor.



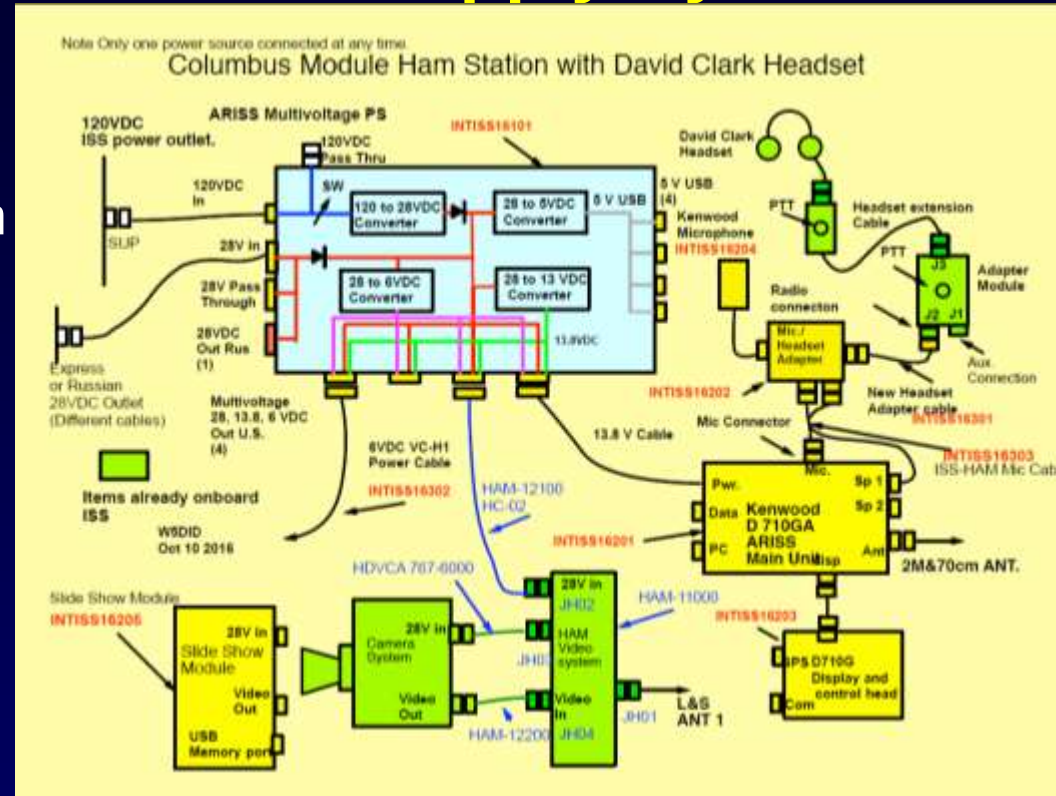
Emanuele D'Andria, I0ELE

Hardware Development Status

ARISS Development Initiative: Interoperable Radio & Power Supply System

Objectives

- Improve Columbus Module downlink signal reception through higher power radio
- Develop standardized VHF/UHF radio & power supply system that shall be interoperable across all ISS Segments and modules
 - Russian Segment: 28 V DC
 - US: 120 V DC (Includes Columbus Module)
- Certify, Launch, Install & operate JVC Kenwood D710GA radio system with ARISS/AMSAT-built interoperable power supply and supporting cabling



Interoperable Radio System

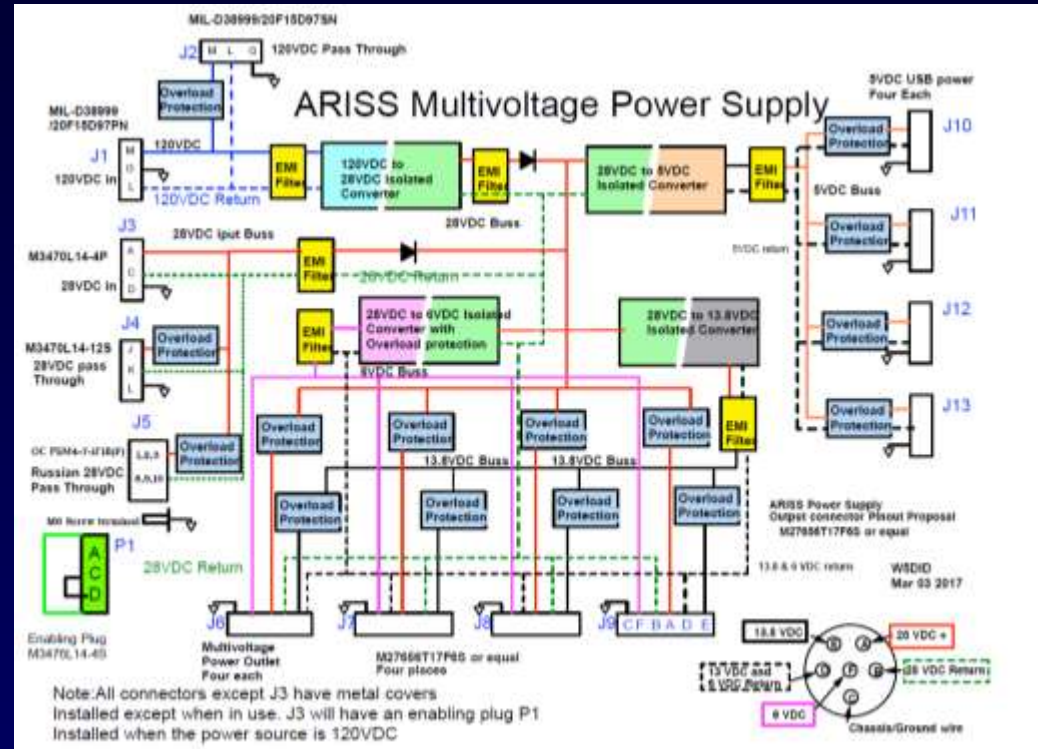


JVC Kenwood D710GA

ARISS Development Initiative:

New system enhancements:

- Higher power downlink improves school contacts, SSTV downlink and APRS operations
- Improved audio during voice contacts
- Reduced Ham TV downtime through dedicated power supply
- More robust soft/firmware in radio system to prevent accidental programming and reduce repeater mode command steps
- New JVC Kenwood D710 fan supports continuous repeater mode operations
- Sharing of hardware resources across modules when failures occur
- Common operations and training across US and Russian segments
- Supports future system developments
 - Ham TV Slide Show module/dedicated camera
 - IPAD SSTV operations
 - Additional radio systems



Muntivoltage Power Supply supports:

- US segment power inputs: 120 & 28 V DC
- Russian Segment power input: 28 V DC
- Four USB power adapters
- Four multi-voltage outputs (28, 13.8 & 6 V DC)
- Two US and one Russian power pass-through (adds additional power receptacles in module)

Interoperable Radio & Power Supply (PS) System Status

- Oct 21 2016: Successful preliminary design review; good data exchange with JSC subject matter experts
- Nov 16 2016: JSC engineers reviewed/critiqued breadboard PS & radio
- Mid-Feb 2017: breadboard PS passed US/Eu/Ru EMC & Power Quality tests!
- August 1 2017: Final Detailed Design Review
- **Nov 2, 2017: Phase 0/1 Safety review (with Phase 2 data included)**
- Fall/Winter '17: Testing & NASA Safety Cert
- 1st Half 2018 (est): Ready for Launch



**Mechanical
Design
Layout**



“Inside View” of Power Supply Breadboard

Multi-Voltage Power Supply Power Quality & EMC Testing at JSC

ISS Power Simulator



ARISS Hardware Load Simulator



Test Setup



Multi-Voltage Power Supply Brassboard



Current MVPS Status

- All electronic boards laid out
- Parts for first 5 systems ordered
- Second 5 to be ordered later
- Flight boards being developed
- First protoflight board (A1 board) built & checked out and
- 5 of 9 boards fabricated



A1-A5 Protoflight Boards

Why is Fundraising for Interoperable Radio System Important?

- Costs for hardware/components ~\$65,000
- Costs for Certification Testing ~\$35,000
- Costs for Safety Certification ~\$100,000
- Domestic & International Travel ~\$15,000
- Administrative Expenses (e.g. shipping, software, configuration mgt, etc) ~\$35,000
- Total ~\$250,000

Your Support is Greatly Appreciated and NEEDED!

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- Total ~~~\$250,000~~ \$150,000

Your Support is Greatly Appreciated and NEEDED!

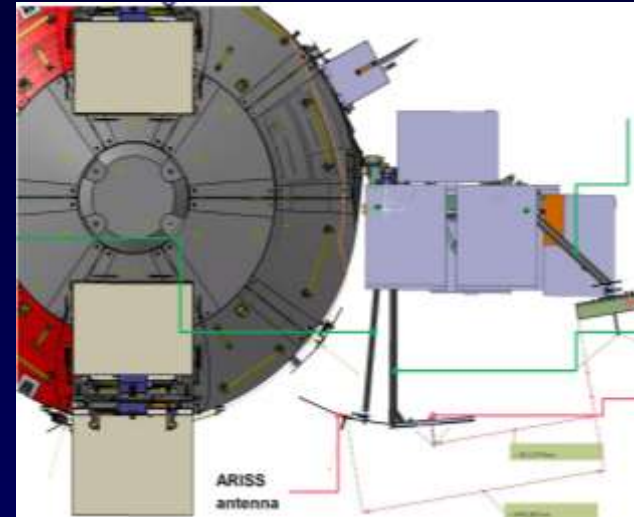
InterOperable Radio System (IORS)

Fundrazr.com

- Estimated total cost for IORS development: **\$150,000**
 - Only after estimated \$100,000 Safety Certification cost savings, through use of volunteer safety data package development team
- Propose using Fundrazr.com to crowd-source fund IORS development; all raised funding tax deductible (in US)
- “Prizes” could include (in order of donation level):
 - Your autograph in IORS on ISS + all below
 - Name/callsign on circuit board mounted in power supply + all below
 - ARISS astronaut signed photograph + all below
 - ARISS new challenge coin--\$100

Bartolomeo

- ESA/Airbus developing external attached payload capability on Columbus module called Bartolomeo.
- Airbus requesting ARISS develop new antenna for launch on SpaceX flight to replace current antenna
- All feedthroughs to be replaced to accommodate other antenna systems, necessitating new ARISS antenna
- High probability Teldasat payload may be deployed along with new ARISS antenna
 - 400.1 MHz UHF “Internet of Things” payload could interfere with ARISS
 - Planning development of internal filter
- ESA has been responsive to ARISS needs; however, issue diverting time and attention from IORS development



Conceptual Visualization
of Bartolomeo Payloads
on Columbus Module

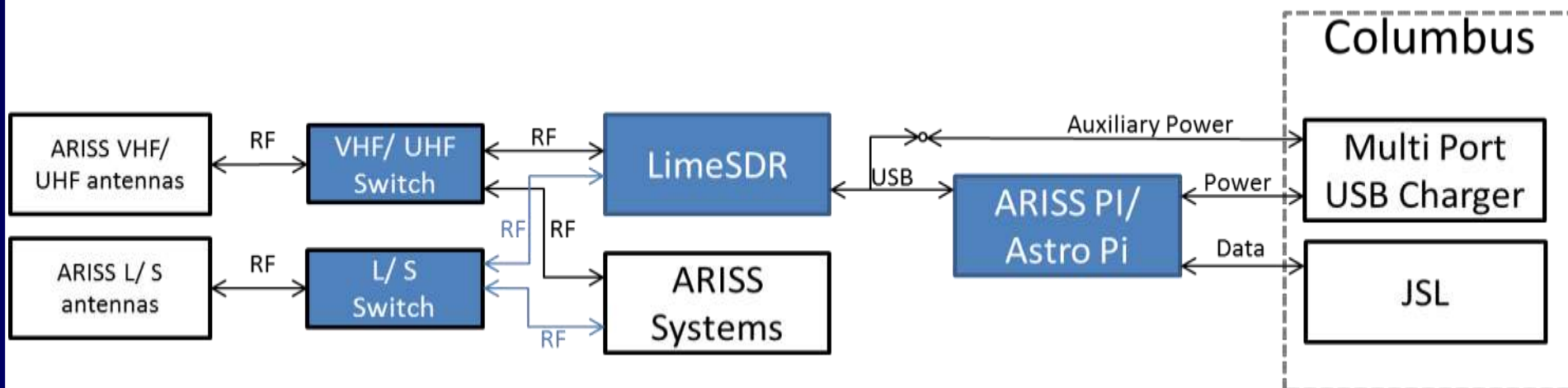
Experimentation

MarconISSta

- from *marconista*, Italian for radio amateur
- On orbit spectrum analyzer for satellite frequency allocations
- **Objectives:**
- Analysis of spectrum use
 - VHF band: 145.80 – 146.00 MHz
 - UHF band: 435.00 – 438.00 MHz
 - L band: 1 260.00 – 1 270.00 MHz
 - S band: 2 400.00 – 2 450.00 MHz
- ISS ARISS antenna analysis
 - Analysis of antenna radiation pattern based on multiple measurements
- Education

MarconiSSta

- **Key components:**
- **RF switches** (VHF/UHF, L/S)
- **LimeSDR**
 - RF Receiver
- **ARISS Pi / Astro Pi**
 - On-Board Computer
 - Data Processing & Forwarding



Noteworthy Event

Russian Students' Educational Satellites Deployed

August 19-20 2017

Five Russian CubeSats, including Tanusha 1 and Tanusha 2, were hand deployed by the cosmonauts from ISS during an EVA. The Tanusha CubeSats began transmitting telemetry and communicated with each other as part of an educational formation flying experiment. Also, student greetings were transmitted in 4 languages.



Tanusha 1 & Tanusha 2 - satellites built by Southwest Western State University students in Kursk, Russia

Become an ARISS Volunteer

We **NEED YOU** to Support
ARISS As...

- Web page developers
- Education committee/STEM Outreach Support
- Ham TV Ground station
- School Group Mentors
- Fundraiser/Business Developer
- Administrative support helpers
- Hardware developers
- Social media coordinators



Inspiration...Exploration...Experimentation

ARRISS Needs YOUR Support!

Two Initiatives Underway



Annual Fund For Operations

Supports

- Operations & Training
- Technical & Administration
 - Enhancing Educational Outcomes
 - Enhancing Public Outreach
 - Improved Communications
 - Business Development
 - Metric Compilation & Analysis

On-Orbit Hardware Capital Campaign

Supports

- Space-rated, Interoperable Radio System, including:
 - Higher Power Radios
 - Dedicated Power Supplies
 - Cabling and Connectors
- Development & Fabrication
- Hardware Certification & Testing



ARRL The national association for
AMATEUR RADIO®

Challenge Coin for \$100+ Donations — Click [ARRISS Donate@ www.amsat.org](mailto:ARRISS_Donate@www.amsat.org)

Seeking Corporate Donations, Foundation Grants, Organization Sponsorships — Contact [Frank Bauer, KA3HDO](mailto:Frank_Bauer_KA3HDO@Gmail.com) at [KA3HDO@ Gmail.com](mailto:KA3HDO@Gmail.com)

2017 Awards



**Amateur of the Year Award
Dayton, OH, May 2017**



**NASA Distinguished Public Service Medal
Langley Research Center, June 2017**



**Ron Broadbent Trophy
Milton Keynes, UK, October 2017**

The Dream is Alive

- Through the dream, vision and hard work of many, permanent ham radio operations is a reality on ISS
- Since its inception 20 years ago, ARISS has become an outstanding STEM and amateur radio outreach foundation on ISS
- ARISS's solid performance and outstanding international teamwork is recognized and respected
- What will we accomplish in the next 20 years?



Frank Culbertson During Scout Jamboree on the Air

***Congratulations to all in the ARISS team for a superb, sustained effort!!
Please keep us sustained with your donations!!***

ARISS Information

<http://www.ariss.org>



Backup Charts

YIAP ARISS Contact April 2016



USA States & Territories, 2000 – Aug 28 2017

*376+ successful school events in 48 states and territories**

Alabama	Iowa	Nevada	Carolina
Alaska	Kansas	New	South Dakota
Arizona	Kentucky	Hampshire	Tennessee
Arkansas	Louisiana	New Jersey	Texas
California	Maine	New Mexico	Utah
Colorado	Maryland	New York	Vermont
Connecticut	Massachusett	North Carolina	Virginia
Delaware	s	North Dakota	Washington
Florida	Michigan	Ohio	West Virginia
Georgia	Minnesota	Oklahoma	Wisconsin
Hawaii	Mississippi	Oregon	Wyoming
Idaho	Missouri	Pennsylvania	*Dist. of Col.
Illinois	Montana	Rhode Island	*Puerto Rico
Indiana	Nebraska	South	

States Needed or Pending